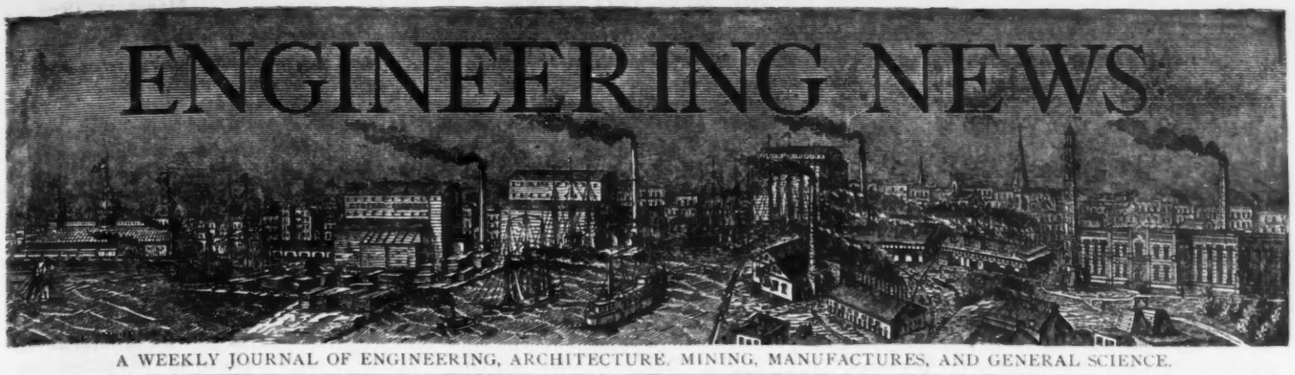
ENGINEERING NEWS



A WEEKLY JOURNAL OF ENGINEERING, ARCHITECTURE, MINING, MANUFACTURES, AND GENERAL SCIENCE.

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American Society of Civil Engineers.

No. 4 TWENTY-THIRD STREET,
NEW YORK CITY.

SIR:—The Committee on Mechanical Engineering of the Centennial Commission of the American Society of Civil Engineers is instructed to aid and direct, to such an extent as may be found practicable, in the presentation at the Centennial International Exhibition of all illustrations of that progress in Mechanical Engineering which has taken place in this country during this first century of the existence of the United States as a nation.

A room has been assigned to this Society by the Centennial Commission in which to place a collection of carefully chosen exhibits, and it is desired to make the limited space accorded as rich in illustration of modern progress in the branch assigned to this Committee as time will permit. It will be necessary to use great care in selecting such illustrative exhibits from among the vast number which exist, in order to secure full illustration without important omissions, and avoiding the overcrowding of the space assigned.

It is desired to obtain—

I. Published works, monographs and manuscripts relating to subjects included in this branch.

II. Drawings and photographs with descriptions of engineering construction.

III. Models of all typical machinery.

IV. Actual constructions where interesting and of moderate size.

V. Valuable and interesting relics.

VI. Biographical sketches, portraits and busts of great American engineers, mechanics and inventors.

Classes I and II can be made to occupy but little space, and the collection can hardly be made too extentensive. Books should, where in sufficient number, be forwarded in cases if possible; monographs should, like the books, be carefully and substantially bound, and especial care should be taken to provide against injury of manuscripts by accident or by careless handling. Drawings and photographs should be arranged in drawers, port-folios or albums, according to the extent of the collection and the size of the sheet. Only exceptionally important and interesting drawings or photographs should be framed, as the wall-space will be very limited and will be largely monopolized by models and portraits. Descriptions of drawings and models should be concise, accurate and amply provided with literal references—on models as well as drawings.

Relics exhibiting early engineering practice are especially desired, and exceptional effort will be made to secure their accommodation. Only magnitude can prevent acceptance of this supremely interesting class.

Portraits and busts of American mechanics and inventors who have become famous in consequence of their success in the earlier days of American mechanical engineering, will be exceedingly interesting to the public at large, as well as to the profession, and well prepared biographical sketches will render them doubly valuable.

The growth of the steam engine and of other motors, in their several typical forms should be shown with great fullness of detail; our peculiar practice in machinery for transmission of power will be well illustrated in Machinery Hall, and this Committee desires to exhibit fully the gradual change of method which has led to it; mining machinery and mill work, textile machinery, metal and wood-working and agricultural machinery, all have a history which is capable of very full and accurate delineation on the plan proposed; every manufacturer of experience and every establishment of long standing and reputation, will be able to make important contributions to one or another, if not to all, of the above named classes.

The Committee desires, at the earliest possible moment, to learn the following:

(*a.*) What you can contribute or secure for this exhibit.

(*b.*) The size, condition and exact character of each contribution.

(*c.*) Whether the contribution will be placed in good order for exhibition, in the hands of the representative of the Committee, at a fixed date, at the rooms of the Society in the Exhibition Building.

(*d.*) What incidental assistance you can give to this enterprise.

As the expenses of this work are borne wholly by voluntary contributions it is desired that such expense shall be spared whenever possible, and any assistance in the collection and installation of exhibits will entitle the giver to the thanks of this Committee and of the profession.

Your co-operation is earnestly solicited, and a prompt reply is requested.

ROBERT H. THURSTON,
Chairman Com. XV.

Stevens Institute of Technology,
Hoboken, N. J., 1876.

Address the Chairman, or G. LEVERICH, C. E., Secretary Am. So. C. E., as above; FRANK H. THURSTON, C. E., Secretary Sub-Committee XV, 280 Bloomfield St., Hoboken, N. J.

TORONTO CORRESPONDENCE.

At the session of the Ontario Legislature recently closed, grants of aid were voted to certain railways in this Province, which may be tabulated as below:

RAILWAY.	Section Aided.	Length of Section.	Rate per Mile.	Amount of Grant.
		Mls.	$	$
Lake Simcoe Junc..	Stouffville to Jackson's Point.....	20	2,000	58,000
Belleville & North Hastings	From near Sterling northward.....	22	3,000	66,000
Cobourg, Peterboro & Marmora.....	Harwood to Ashburnham.....	13	2,000	26,000
Credit Valley.....	Brock Road to Ingersoll.....	52½	2,000	160,000
	Cataract to Elora..	27½		
Stratford & Lake Huron	Stratford to Listowell	25	2,000	50,000
Victoria	Lindsay to Kinmount	33	1,000	33,000
Montreal and Ottawa Junction.	Boundary of Ontario and Quebec to Ottawa	66	1,000	66,000
Midland	Waubashene to Midland Bay.....	13	1,750	22,750
Grand Junction....	Stirling to Peterboro	45	1,000	45,000
Kingston & Pembroke	Sharbot Lake to Mississippi River	16	3,750	60,000
"Neutral Link," (as below)	Gravenhurst to C. P. R.....	342	8,000	586,750
		80		64,000
	TOTALS.....	422		1,226,750

The government took power to grant to a company, now or hereafter to be chartered, aid to the extent of $8,000 per mile, for the construction of a "Neutral Link Railway," to connect, at or near Gravenhurst in the Muskoka District, the existing system of railways in this Province, with the projected Canada Pacific Railway, at some point west of the eastern end of Lake Nipissing. Such grant "to be only upon proper conditions for securing full running powers and other rights of user to other railways," and upon such other conditions as the Governor in Council may require. The line will be about 80 miles long.

At the same session a bill was passed to make null the printed conditions of railway shipping bills whereby the companies seek to escape liability for damages to goods: so that hereafter damages caused by the carelessness or negligence of the Companies' servants, must be made good to the shipper.

The Port Dover & Lake Huron railway is so far completed that on the 3d inst. a passenger train ran over the line from Port Dover, on Lake Erie, to Stratford, on the Grand Trunk Railway, a distance of about 70 miles. This new railway intersects the Great Western Air-line at Simcoe, the Canada Southern at Hawtrey, the Great Western main line at Woodstock, and the Buffalo and Lake Huron railway at Tavistock. It is intended to proceed at once with the construction of the railway northward to Colpoy's Bay, its intended terminus on Lake Huron.

W. K. Muir, Esq., has not, as rumored, retired from the general management of the Canada Southern Railway.

The Quebec & St. John Railway Company expect to begin building their railway next summer.

As evidence of the extent of our banking business I may mention that there are 178 bank clerks employed in this city.

The office of Chief Superintendent of Education has been abolished, and the control of our schools placed under a new department of the Government. Rev. Dr. Ryerson who has been Chief Superintendent for about 36 years retires upon a well earned pension of $4,000 a year, and the Honorable Adam Crooks, late Provincial Treasurer, has just been sworn in as Minister of Education. The Dr. leaves behind him what we Canadians believe to be the best educational system in the world—established through his labors, over opposition from all shades of religious and political opinions. The change is to a great extent experimental, and it is at least questionable whether the consequent introduction of politics into the school system will not have a damaging effect upon it. The Doctor, though now nearly seventy-three years of age, does not intend settling down in idleness, but proposes completing an historical work upon which he has been for some time engaged. A prominent actor in the greatest events that have taken place in this country during the present century, his book will be looked for with great interest.

CANADENSIS.

Toronto, Feb. 29, 1876.

New York Public Health Association.

An adjourned regular meeting of this Association was held on Thursday evening, Feb. 14th, at the rooms of the Medical Society, 12 West 31st St. Professor Chandler, President, in the chair. A plan of re-organization was submitted by the Committee appointed for the purpose, which was duly adopted by the Association. The changes thus inaugurated are of considerable importance, and tend to make the society occupy a more prominent and useful position than heretofore. They chiefly comprise the appointment of ten Standing Committees on various subjects, a few of which are Sanitary Condition of New York City and Vicinity, Adulterations of Food, Disinfectants, Quarantine, City Sewerage and Drainage, Water Supply, House Drainage, etc.; also the election of all Honorary Members to active membership. The Standing Committees each consist of several members representing various professions,—including physicians, sanitary engineers, civil engineers, architects, journalists, and others; and the united wisdom of these various professions are calculated to produce much in their stated reports of practical value and interest to the public at large. This union of the medical with the engineering and architectual professions is a decided step in the right direction.

The paper for the evening,—"The History of Diphtheria,"—by Dr. John C. Peters, of cholera fame, was then read and discussed, after which the meeting adjourned.

Water-Witching.

As corroborative of Mr. Latimer's opinion, we may mention that an ignorant but conscientious man of our acquaintance, never failed to indicate the spot at which water might be found. He used a forked branch of willow or witch hazel. He said the depth which one must dig was equal to the distance from the point at which the rod began to turn, to the point at which the rod turned directly down, thus agreeing with Mr. Latimer's 45°. Two "water-witchers" of my acquaintance at different times, and unknown to each other, indicated the same spot for digging a well.

B. F. D.

The report of the March meeting of the Engineers' Club of St. Louis will appear in our next issue.

HEAT AND COMBUSTION.

Second Paper read before the 'Railway Polytechnic Society,' Cleveland, Ohio, Nov. 15th, 1875.

BY P. H. DUDLEY, C. E.

[CONTINUED]

FELLOW MEMBERS:—In the former paper on "Heat" we closed with some remarks upon the economy of using steam expansively, which stated, in a measure, the theoretical advantages; the practice is not fully up to theory.

Although Watt invented the "Steam Jacket," it has not been in general use, and much of the benefits of expansion have been lost. A portion of the steam liquifies in expansion unless heat is applied to the cylinder. A much larger portion of heat is lost by radiation from the want of properly protecting the cylinder by steam jackets or efficient lagging. Steam at 75 lbs. pressure has a temperature of 152° Centigrade; at 20 lbs. pressure, 110°; at atmospheric pressure, 100°. If steam at 75 lbs. pressure is exhausted at 20 lbs., the temperature will be reduced 42°; according to the "theory of exchanges," or I might say principle that, when we bring together two bodies of different temperature, the tendency is for each to transfer heat from one to the other, until the temperature is in equilibrium.

In the example stated, the change of temperature due to that of the steam is 42° C.; the warmer steam is constantly being admitted to the cool end of the cylinder, and a portion of heat is taken from the steam to warm the latter. In fact, the cylinder could be so large and be kept so cool, that all of the steam would be condensed and no motion of the piston be produced. The slower the stroke and want of proper protection to the cylinders, the greater is the loss of heat, which is so much taken from the desired useful effect.

Since the mean pressure on the piston is reduced by expansion, to obtain its benefits the cylinder must be enlarged to make up for the loss of pressure; consequently the surfaces exposed to cooling are increased and another loss takes place. The machinery of the engine may be so large and complicated, and therefore so much more expensive, that, in the final results upon the ledger, no economy will have been produced. It is not an economy in fuel alone that is desired, but one which shows on the credit side of the balance sheet.

Those of us who had the pleasure of listening to the Presidential address of Mr. Holley before the Mining Engineers, will long remember his statement of the decided advantages of using steam more expansively and the positive necessity of using heat more economically. The saving is not confined to any one branch of business, but all are concerned. We must not expect all the benefit to be derived by simply having a good engine, as it performs but part of the functions necessary to gather up the energy of the fuel. The furnace and boilers must also be complete.

I cannot close this part of the paper on expansion, for the present, more appropriately than by quoting from the Inaugural Address of the eminent engineer, Sir John Hawkshaw, as President of the British Association, which convened at Bristol last August. He says:

"It is a question of vital importance to the steamboat that the consumption of fuel be reduced to the smallest possible amount, inasmuch as each ton of fuel excludes a ton of cargo. As improvements in the form of the hull are effected, less power, that is less fuel will be required to propel the vessel through the water a given distance. Great as have been the improvements effected in marine engines to this end, much remains to be done. Wolfe's compound engine, so long overlooked, is, with some improvements, being at last applied. Where the consumption of fuel in such vessels as the Himalaya used to be from five to six pounds of fuel per effective horse power, it has been reduced by working steam more expansively in vessels of later date two pounds. Yet, comparing this with the total amount of energy of two pounds of coal, it will be found that not a tenth part of the power is obtained which that amount of coal would theoretically call into action." * * * *

Further on in his address he says: "Dr. Siemens," (the inventor of the open hearth furnaces used here in the Otis Steel Works,) "in an able lecture delivered by request of the association, pointed out the waste of fuel in special branches of the iron trade to which he has devoted so much attention. He showed on that occasion that in the ordinary reverberatory furnaces the coal consumed did not produce the twentieth part of its theoretical effect, and in melting steel in pots in the ordinary way, not more than one-seventieth part; in melting one ton of steel in pots, about two and a half tons of coke being consumed. Dr. Siemens further stated that in his regenerative gas furnace one ton of steel was melted with twelve hundred weight of small coal.

"Mr. Lowthian Bell, who combines chemical knowledge with the practical experience of an iron-master, in his Presidential Address to the members of the Iron and Steel Institute, of 1873, stated that with the perfect mode of withdrawing and utilizing the waste gases, and the improvement in the Cleveland district, (England,) the present make of pig iron in Cleveland, England, is produced with three and a half millions tons of coal less than would have been needed fifteen years ago, this being equivalent to a saving of forty-five per cent. of the quantity formerly used. He shows by figures, which he has given me, that the calorific power of the waste gases from the furnaces is sufficient for raising all the steam and heating all the air the furnaces require. It has already been stated that by working steam more expansively, either in single or double engines, the consumption of fuel in improved modern engines compared with the older forms may be reduced to one-third. All of these reductions fall far short of the theoretical effect of fuel which may be reached; but much has already been done, and could the reductions now attainable and all the information already acquired be universally applied, the saving in fuel would be enormous. If I have pointed out that we do not avail ourselves of more than a fractional part of the useful effect of fuel, it is not that I expect we shall all at once mend our ways in this respect. Many cases of waste arise from the existence of old and obsolete machines, of bad forms of furnaces, of wasteful grates existing in most dwelling houses, and these are not to be remedied at once, for not every one can afford, however desirable it might be, to cast away the old and adopt the new. In looking uneasily to the future supply and cost of fuel, it is, however, something to know what may be done even with the application of our present knowledge, and could we apply it universally to-day, all that is necessary for trade and comfort could probably be as well provided for by one-half the present consumption of fuel, and it behooves those who are beginning to build new mills, new furnaces, new steamboats, to act as though the price of coal which obtained two years since had been the normal and not the abnormal price."

I have quoted extensively to show you the importance and consideration given *heat* by the leading men of the day. So extensive are its uses that its economical generation and application not only affects large corporations, but the individual members of communities. From the attention paid to this subject by others, I think it is evident to all that I am not trying to call undue attention to the daily increasing importance of using heat (*i. e.* capital) more economically. It is the great and main engineering force or energy, by which we are enabled to carry on our manufacturers and transportation.

If heavy grades and sharp curves are introduced in our railways, excessive dead weight in the cars, and poor forms for vessels, more power (*i. e.* heat, which represents so much money) must be used to overcome the increased resistances induced. The literature upon the development and application of heat is very voluminous and oftentimes quite contradictory, which has doubtless arisen from conclusions formed from observations made under quite dissimilar circumstances, but considered as the same. Perhaps the greatest diversity exists among the applications intended to combine the principles of combustion. It would take more time to simply mention them, exclusive of description, than is usually taken to read a paper like this. It is really surprising to see what a vast number of boilers, fire-boxes, grates, and engines of more or less complexity and utility, have been devised. Some, with an idea of saving in the fuel, have increased the first cost of construction and consequently the subsequent cost of repairs, to such an extent that the saving effected in fuel is more than counterbalanced by interest and repairs. Simplicity is an important consideration, especially when applied to matters of transportation.

So conflicting are the reports of the efficiency of the more ordinary appliances for the purpose of inducing perfect combustion, that it requires much care to select those which are good, and it is only by experience with them in actual use that we judge of their practical value. It is quite easy to see or calculate the final work done by any machine; yet, if it has more than one function of action to perform before the work is accomplished, we are only able to judge of the efficiency of the whole, and not as to the value of each function. In using heat to produce work through or by the steam engine, four quite marked functions are called into action:

First—Development of heat in the fire-box.

Second—Its absorption by the water.

Third—The development of the power in the cylinder.

Fourth—Its application to the machinery from the piston through the crank.

It is to the method of judging of the first that I wish to call your attention. As I stated in the former paper, the products of perfect combustion would be carbonic acid gas, water or steam, and the unconsumed nitrogen. Usually, however, we get some hydro-carbons. As shown upon the drawing, the air consists by volume in 100 parts, of 21 parts of oxygen and 79 of nitrogen. If we were using pure carbon and the oxygen were all consumed, the carbon would combine with the oxygen, and the two together would only occupy the same volume as the oxygen, but the density of the gas would be increased. In our coals there are some impurities which make up from one to three volumes of gas in one hundred. In the former paper we gave a formula for calculating the calorific value and calorific intensity of fuels when their chemical composition is known, and we also pointed out the loss of heat when carbonic oxide was formed, or an excess of air was admitted. Generally speaking, the carbon and hydrogen of the coal are the only heat producing elements worthy of consideration. The oxygen of the coal being already in combination, does not furnish any heat, but takes it away from the other elements. Knowing what we should have in perfect combustion, if we analyze the products it must be obvious that it will show the completeness of combustion. I am well aware that it is perhaps quite common for chemists to analyze gases in the laboratories, usually requiring two or three days to complete a single analysis. It was not until quite recently that apparatus has been so devised that it can be done rapidly.

I have recently taken up the matter for the purpose of finding out, if possible, why it is that we do not obtain a greater percentage of the power in the coal. I have not designed a furnace and then expected to find (subvert) facts to support the design, but first wish to find out the facts, then, if needed, design an apparatus. It will be more logical and probably of greater utility. My object, in presenting to you any account of the incomplete investigations, is to show their importance, hoping that means and opportunities for making them may be much increased and extended.

The analyses are only true in a commercial sense—approximations to the real exact relations of the gases. The ordinary operations of weighing are only approximations when compared with the delicate weighing performed by chemists. It might seem at first, since we do not know, by measurement the amount of air admitted to the fire, that the results would be inaccurate; but the chemical elements only combine according to definite laws. The arrangement of the fire-box and surroundings may be very elaborate, yet, if proper conditions are not supplied for combustion, the elements will not be coaxed into the perfect combinations, and only so much in quantity, no more or less, excluding or making up for an excess of any element, will enter, so that the results of the analysis by volumes show the comparative relations of the products of combustion, except as to the amount of steam or water that is formed.

At first the experiments were confined to locomotives in the freight yards here in the city. In October, through the courtesy of Mr. Chapman, master mechanic of the Cleveland & Pittsburgh Railroad, and his associates, I was enabled to pass over the railway and observe the application of heat upon the motive power under his care. We had two objects in view: First, to obtain the gas for analysis under the ordinary conditions of working; second, to determine the amount of water evaporated per pound of coal used. To facilitate my work a day run was selected and the experiments were made upon one of the standard freight engines, No. 84, designed by Mr. Chapman and built in the company's shops in this city in December, 1872, which had run 80,000 miles upon freight trains without being off her wheels for repairs. The flues are the same ones first put in, and are doubtless somewhat incrusted with mud and lime. The water on the road is taken from the lake, small streams, springs, wells, and the Ohio River, and upon the whole is not so hard as many roads are obliged to use, neither is it as soft. From the chemical composition of the coal, and at the temperature of the water during the month of October, the coal should theoretically evaporate eleven pounds of water. I took the analyses of the coal from State Reports, and I presume the sample was selected with more care than the coal used by the railway compa-

ny, as we found ten per cent. of cinder in it. The steam from burning the coal was all condensed before we could get the gas back to the apparatus for analysis, as some of it was sent back from 20 to 60 miles to Cleveland and analyzed by our worthy treasurer, Mr. H. P. Kinsman, C. E., who has assisted and rendered important service in the investigations.

That we may fully understand the results, I will give the dimensions of the fire-box, heating surfaces and plan of grate. The boiler and fire-box of the locomotive are of steel. Length of fire-box 60 inches, width 35½ inches, and height 62 inches from the bottom of the mud-ring. The grates take up 6 inches, so that it is only 56 inches from the grate bars to the crown sheet, making a space of 69 cubic feet for the fire and combustion chamber, which has 85 square feet of heating surface exclusive of door and flue openings. There are 128 flues, 2 inches external diameter and 11 feet and 10 inches long; the internal heating surface of them is 681 square feet; the volume of the flues per foot 2.1 cubic feet, or simply the opening 2.1 square feet; the size of exhaust 4¼ inches; the effect of the blast was generally sharp enough to throw out small pieces of coal ⅛ of an inch in diameter through the netting of the smoke stack. The running and firing were performed the same as when not making experiments. Heretofore in collecting the samples of gas they were taken directly from the fire-box, but on this engine we took them from the smoke stack after they had performed their work, and no further change would probably take place in their composition. In one respect we found this a great improvement, as the gas was sufficiently cooled so that it did not destroy the valves of the pump used to collect the gas, which it did in the former case, requiring renewal for nearly every specimen. The grate is composed of five rocking bars, each bar being 29½ inches long by 10⅜ inches wide, with 28 air spaces ½ inch wide by 6 inches long. The air space between each bar is from ½ to ¾ of an inch wide and there is the same space at the ends. There is a dead-plate 3¼ inches by 29½ long. The steam was regulated in a measure by the throttle-valve. The weight of the train on some days was quite variable. After a fresh fire the black smoke would be from 1 to 1.5 minutes in passing off, depending somewhat upon the size of the lumps of coal and the sharpness of the blast. Upon an undulating road the locomotive is constantly working under different circumstances which affect the blast. I have prepared a short table of analyses, and also graphically represented them by drawings. In the table CO_2 represents carbonic acid gas, **CO** carbonic oxide, **O** oxygen, and **N** nitrogen.

	CO_2	CO	O	N	
1...	11.3	.....	7.2	81.5	Yorkville Coal
2...	13.3	.....	4.7	82.0	
3...	14.0	.....	4.0	82.0	
4...	12.5	.....	6.0	81.5	
5...	10.0	.....	.....	.....	Apparatus broken: could not complete any further analysis to-day.
1...	10.5	.....	8.0	81.5	Black smoke.
2...	12.5	.....	.....	.....	No smoke visible.
4...	10.5	0.5	5.5	83.5	Damper closed.
5...	9.9	.....	9.6	81.5	Black smoke.
6...	12.3	.....	5.2	82.5	White smoke.
7...	12.0	1.5	3.5	83.0	Damper closed.
1...	9.6	.....	9.7	80.7	Saline ville Coal.
2...	12.9	.....	6.5	81.6	No smoke visible.
3...	13.8	2.5	2.5	81.6	No smoke visible.
4...	13.4	1.0	5.2	80.4	No smoke visible.
5...	14.0	.....	3.8	82.2	No smoke visible.
6...	12.5	.....	5.8	81.7	
7...	14.2	.....	3.6	82.4	

We should get at least twenty per cent. of carbonic acid gas (by volume) if the oxygen of the air were all consumed. Since some hydro-carbons were present in most cases, the per cent. given in the Nitrogen column, which includes all gases except CO_2, **CO**, and **O**, was seldom so small as 79.

We tried to take as average specimens as could be obtained under ordinary working conditions. The engineer, Mr. Shannon, and his firemen, rendered me all possible assistance they could. Yet, to make the experiment as complete as possible, it needs a trained assistant who can observe the firing while the gas was being collected, as it is all one man can do to hold on to the engine and pump the gas from the smoke-stack. In ascending the heavy grades the rapidity of firing was from 2.5 to 4 minutes, using about 50 pounds of coal for each fresh fire. The speed of the train was from 10 to 15 miles per hour on the grades. When the road was level or nearly so, the firing was from 4 to 7 minutes, and the speed from 15 to 18 miles per hour. Steam was carried at from 125 to 130 pounds pressure, with the reversing lever in the second or third notch from the center.

ANALYSES OF GAS FROM THE LOCOMOTIVES IN THE FREIGHT YARDS OF THE CITY.

	CO_2	O	N	REMARKS.
1...	11.5	6.0	82.5	Old fire; escaping gas white; engine working hard.
2...	8.5	8.0	83.0	Fresh fire; much black gas escaping; engine working hard.
3...	13.5	4.0	82.5	Old fire; escaping gas light colored; engine working moderately.
4...	7.5	12.5	79.0	Engine standing still with blower on.
5...	2.3	17.2	80.5	Engine standing still; old fire; damper closed; supposed to be Massillon coal. At this time the fire-box had in a brick smoke arch, and the gas was taken from under it.
6...	7.4	12.6	79.0	HC 1. Taken from the top of the smoke stack; engine not working hard.
7...	1.5	18.9	79.6	Engine working hard; gas taken from the fire-box under the brick smoke arch.*
8...	3.4	16.9	79.7	Engine working hard; escaping gas white.†
9...	3.6	16.7	79.7	Engine working hard; escaping gas white.†
10...	1.5	19.2	79.3	Engine working hard; escaping gas very black; new fire.†
11...	7.5	11.8	80.7	Fire door wide open; old fire; just starting from Union depot with train.
12...	3.0	17.2	79.8	Engine moving slowly; new fire; smoke black.
13...	6.6	13.0	80.6	Engine moving slowly; old fire. In all of these specimens the gas was taken from the fire box.
14...	14.0	4.0	82.0	Engine working hard; hauling 20 loaded cars up a 40 foot grade; old fire; escaping gas white.
15...	8.6	10.3	81.1	Engine working hard, with same load as above specimen, but a new fire.

Locomotives:
Nos. 1, 2, 3 and 14, 15, Pony engine, No. 12, C. & P. R. R.
No. 4, Wood burner, L. S. & M. S. R'y.
Nos. 5, 6, 7, 8, 9, 10, engine 197, do.
Nos. 11, 12, 13, engine 140, C., C., C. & I. R'y.

*The striking contrast in the amount of carbonic acid gas between the engines of the two roads led me to repeat the experiments upon Engine 197 the following day while it was hauling trains out to Collingwood. The gas was collected from the fire box. I think the small percentage of carbonic acid gas and large percentage of oxygen was owing to the fact of collecting the gas from under the smoke arch, as subsequent experiments with the smoke arch taken out show different results.

†These three specimens were taken under quite similar circumstances except as to fresh coal being put on the fire. The brick smoke arch was in and the gas taken near it and perhaps under it.

The above are sufficient to show the average results of analyses of gas obtained from locomotives in the yards. The results from Engine No. 197 of the Lake Shore and Michigan Southern Railway were so different from the others that I have recently taken them again, with the following results. The brick smoke arch was out:

	CO_2	CO	O	N	REMARKS.
16...	5.7	.....	14.7	79.6	Engine working hard; old fire; smoke white.
17...	8.4	1.2	8.4	82.0	Same engine; new fire; not working hard.
18...	12.0	1.0	4.4	82.6	Same engine; smoke black; not working hard.
19...	6.0	.....	13.5	81.5	Same engine; working hard; smoke white.
20...	3.4	.....	16.8	76.8	Engine 148, L.S.& M. S. R'y; standing still; blower on; smoke dark.

Now if we compare these results, especially those upon the Cleveland and Pittsburgh Railroad, we find in every instance as the black smoke decreased, the carbonic acid gas increased. In the coal they use, some hydro-carbons are given off, so that the final reading is not down to 79, which it should be, provided they did not exist and no carbonic oxide was formed. Another fact which can be observed is, that when the black smoke was escaping, the results show that there was still theoretically an excess of oxygen in the fire-box, but it passed in through the grates, showing that something else besides its presence is necessary to make it enter into combination with the gases of the coal. Our coals (the bituminous ones) contain, besides the fixed carbon, a portion which is volatile, and before the fixed carbon takes the fire the gas is driven off. Now if the temperature of the air is sufficiently high and properly admitted, the volatile gases when first driven off will ignite. In many of the so-called smoke burners, the important principle of an igniting temperature is wholly ignored. The oxygen and hydrogen seem to combine at a much lower temperature than oxygen and carbon, and the consequence is that we find, in most of our furnaces, the temperature so low that the carbon (volatile portion) passes off in the form of soot, or the so-called black smoke. Incomplete combustion of fuel is often caused by the chilling and extinguishing of the flame through contact with the surface of the boiler before combustion is complete. In fact, this may be seen by holding any cold metalic substance in a gas flame, which is at once cooled so much that the carbon is deposited as soot. The flues are so small that they at once extinguish the flame.

There is a wonderful confusion on this question of burning up the smoke. Some writers say "that the smoke is caused by an insufficiency of air, and carbonic oxide is formed, and in escaping we see it as black smoke."

Carbonic oxide is invisible, and does not color the escaping gases black. When the smoke is the blackest we scarcely find a trace. In fact, many smoke burners simply convert the products into carbonic oxide, which is invisible, and suppose they are effecting an economy by burning up the smoke. Another fallacy is, that when the escaping gas is white, no loss of heat is occurring. Take the analyses given; only six per cent. of carbonic acid gas is given off, and the smoke invisible, showing at once that a large excess of air is drawn through the grates, consequently the caloric intensity of the fire is cooled down by the vast amount of heat carried off by the gases.

To show more clearly the benefits of the analyses, we will consider the effects of incomplete combustion and also the admission of too much air. We must bear in mind constantly that a pound of coal only contains a certain quantity of heat, and we cannot increase it.

The burning of the carbon is always complete at first; one pound of carbon combines with 2⅔ pounds of oxygen, producing 3⅔ pounds of carbonic acid gas, and, although the carbon is solid immediately before combustion, it passes during combustion into the gaseous state. This terminates the process when the layer of carbon is not too thick, and the supplyof air not too small, so that a sufficient quantity of oxygen can get direct access to all the solid carbon. The quantity of heat produced would be 8080 thermal units of the centigrade scale. But in other cases part of the solid carbon is not supplied directly with oxygen, but is first heated and then dissolved into the gaseous state by the hot carbonic acid gas from the other parts of the furnace. The 3⅔ pounds of carbonic gas formed from 1 pound of carbon, will take up another additional pound of carbon, making 4⅔ pounds of carbonic oxide gas, and the heat produced, instead of being that due to the complete combustion is only 5599 units, showing a loss of 2481 units of heat. I speak of furnaces where the carbonic oxide is not afterwards burned. In the former paper, by the formula for the calorific intensity of the fuels burnt in oxygen and the air, we found that the calorific intensity of carbon burnt in oxygen was 10,175°, and when burnt in the air 2720° C. because the unconsumed nitrogen of the air had to be heated up as well as the oxygen and carbon. If we had supplied double the air necessary to burn the carbon, the calorific intensity would be reduced to 1341°. It will be seen from the above that a loss occurs from either a deficiency or an excess of air. All of the analyses show that a portion of the oxygen was unconsumed, and that much less air would do theoretically. It can be stated as a common rule that our bituminous coals require 12 pounds of air to burn each pound of coal. At ordinary temperatures 12 pounds of air will occupy 150 cubic feet; to burn one ton of coal therefore requires 300,000 cubic feet of air, which when heated to the temperature of the locomotive furnace, more than doubles in volume, and it all must pass through the flues at a great velocity, requiring a strong blast to overcome the friction of the small orifices. Suppose, now, that you double this quantity of air. You cool down the furnace and at the same time increase the difficulty of making the products of combustion pass through the flues. To get the required blast the steam must exhaust from the cylinders at a much higher pressure, resulting in a loss of power in more ways than one, We will only mention three ways:

First—The loss of the heat carried away by the increased volume of the products of combustiou and unconsumed gases.

Second—The loss of heat by the release of steam at high pressure.

Third—The loss of conduction of the heat, as that is nearly in proportion to the square of the difference of temperature. This last is a very important matter.

Mr. Johnson, in making his experiments to determine the best steam coals to use for our navy, considers that it is necessary to admit a certain excess of air, generally equal to that required for combustion, to dilute the gaseous products, when the draught is produced by means of a chimney. There the air enters with a much slower velocity, and the gases are not so forcibly mixed as in furnaces where a blast is used. If admitted in the prop-

(Continued on page 98)

ENGINEERING NEWS.

SATURDAY, MARCH 11th, 1876.

GEO. H. FROST, - Editor and Publisher.

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TABLE OF CONTENTS.

American Society of Civil Engineers - - - 81
Toronto Correspondence - - - - - 81
New York Health Association - - - - 81
Water-Witching - - - - - - 81
Heat and Combustion - - - - - 82
U. S. Land Survey and the Metric system - - 84
Kansas City Water Works - - - - 84
Remarks on House Drainage - - - - 86
Civil Engineers' Club of the Northwest - - - 86
Publications Received - - - - - 87
Contractors' Intelligence - - - - - 87
Proposals for Contracts - - - - - 87

Notice of Meeting.

The regular meeting of the Academy of Sciences will be held Tuesday evening, March 14th, at 7:30 o'clock.

UNITED STATES LAND SURVEYING AND THE METRIC SYSTEM.

A correspondent, in the number of the NEWS for Feb. 26, thinks that the introduction of the Metric System will entail much inconvenience on those Surveyors who practice in States where the land is divided on the United States rectangular system. The matter may be viewed from the stand-point of one who has to retrace old lines and to make sub-divisions, or of one who is engaged in running out original section lines. Our correspondent speaks of himself as belonging to the former class.

Let us see how lines will be retraced or sub-divisions will be made, if we have a new unit of measure, the metre. The old lines being fixed by bounds or corners where they exist, the new measurements, which are never the same with one chain as with another, can be recorded in metres as readily as in chains. If the corners are not found, the law prescribes how they shall be restored; the directions are as good for one unit as another. The theoretical square mile is practically a quare mile. A reference to the cited lengths of the sides of different sections and quarter-sections in recent numbers of this paper will show this to be a fact. When sub-divisions are to be made, the actual lengths are usually measured, and then halved, etc. Metres may be divided as easily as any other measure, where the ascertained length involves fractions of a unit. It cannot make any difference by what standard the lines are measured, the middle point of division will be found at the same place. If a metre is the legal standard, the distances can then be recorded in metres and the contents computed as readily as if the figures were in chains.

There will be cases where it is necessary to change chains, rods, feet, etc., into metres and decimals. The multipliers are not troublesome. For instance we shall have

1 Chain = 20.12 metres,
1 Rod = 5.03 "
1 Yard = 0.915 "
1 Foot = 0.305 "
1 Link = 0.2012 "

If the fractions of a foot are not smaller than tenths, the above decimals, with the exception of the first, need only be carried to one place. The multiplications can then be performed in the head.

Now let us see what may be done in the way of making new surveys. If we go on in the present way we may need simply to compute the quantity, 80 chains, in metres, once for all, and use it where we now use the former quantity. But the allowable legal error or discrepancy is one chain per mile, or *one* in *eighty*. The number of metres in a mile are 1609.347. If then a section is prescribed to be 1600 metres square *theoretically*, it will not differ from the present prescribed section by one-half the allowed error in the length of any side, and the sections as *actually measured* will be practically the same as now. The sub-divisions of 800, 400, 200, and 100 metres are very simple, and just as good as the sub-divisions of 80 chains. The contents of this section would be 632.39 acres, of a quarter section 158.1 acres, and the other portions would contain 79 acres and 39.5 acres. The *actual* sections, etc., would come as near the legal contents as they do now. As an acre would not be a convenient unit in a metric system, we should have some other unit of square measure, but we should have just as much land.

To conveniently lay out the above sections, it is suggested that we have a new chain, 25 metres long, and having 125 links. We can then write our table

64 Chains = 1 side of section.
32 " = 1 " " ¼ "
4 " = 105 metres.
5 Links = 1 "
1 " = 0.2 " = 2 decimetres.
0.5 " = 0.1 " = 1 "
0.1 " = 0.02 " = 2 centimetres.

It seems then as if the divisions of the United States Land Survey may be run and re-run without involving troublesome ciphering, even if the unit of measure is changed, and that, in giving up the Gunter's chain, which has for its sole merit its decimal relation to an acre and its convenient fractions of a mile, we gain enough to offset the slight inconvenience.

No. XIII of Graphical Analysis of Roof Trusses is omitted this week, but will appear in our next. The continued and growing popularity of this simple method of analysis, among Architects and Civil Engineers, is most plainly evinced by the rapid sale of such publications on the subject as Prof. Du Bois' "Graphical Statics," and Prof. Greene's "Graphical Analysis of Bridge Trusses," the two most noted works on the subject now on sale in the United States. We are also very much gratified at the success of the present series of articles in the "Graphical Analysis of Roof Trusses," which are being read by more Architects and Civil Engineers than is perhaps any other similar series of articles in this country, and with the rapidly increasing circulation of ENGINEERING NEWS the interest in them is spreading among even the most conservative members of the profession.

The publication of the paper "Riparian Rights," read at the Club meeting on Tuesday evening, is postponed one week .Mr. Greeley has given a large amount of time and labor to the preparation of this paper, and we think that it will be conceded to be one of the very best presentations of the subject that has ever been placed before the public. The paper is of considerable length and is illustrated with maps which appeared in some of the most important land suits that have ever been before the U. S. Courts. These cases have occurred in Boston, Chicago, and St. Paul, and the amounts involved were reckoned almost by millions of dollars. We commend the paper to lawyers, surveyors, real-estate owners, and all others interested in this very important subject.

The meetings of the Civil Engineers' Club of the North West are steadily gaining in interest and value. On Tuesday evening last fully one half of the whole membership was present, and it was particularly gratifying to see the large number of non-resident members who were present. Owing to the lateness of the hour at which the meeting commences, and the necessity of many members having to leave by the early evening trains out of the city, but a very short time can be given to the discussion of papers, and with the growth of the society there is a corresponding accumulation of business each month that must be attended to in the short interval that is allowed for the regular session of the Club. We do not see but that the time for meeting will have to be made a half hour earlier, in order to do justice to the subjects that are brought before the members, and we commend to the Club the proposition to make such alteration.

With the exception of the American Institute of Mining Engineers, which has for its official organ the widely circulated *Engineering and Mining Journal*, no other society in this country has so great a publicity as the Civil Engineers' Club of the North West. While the carefully prepared and valuable papers of the American Society of Civil Engineers are confined almost exclusively to a distribution among its own members, those of the C. E. Club are scattered broadcast throughout the country. In our search for new subscribers we are sending ENGINEERING NEWS into every city and town in the Union and Dominion, and it is not unfair to suppose that nearly every paper is examined and criticised by at least four or five persons. Already the effects of this publicity is being felt by the society, and, while we do not claim for ourselves particular credit for advancing the interests of the Club, yet we cannot but feel that we have assisted in awakening an interest among engineers that is now being made manifest.

We want to see the Civil Engineers' Club of the North West a strong, influential, and powerful society, a membership in which will be a recommendation of value to any engineer, wherever he may be engaged. And there is no reason why such a condition of things may not soon be brought about. It already has on its list of membere the names of men second to no others in their profession; its headquarters is located in the second city in commercial importance in America, it has passed through the season of the uncertainty of existence which marks the early history of all such societies, and with a rapidly increasing membership it is now entering on an era of progress that will soon place it side by side with the other great societies heretofore mentioned.

The interest of the monthly meetings will depend almost entirely on the attendance of members, and it is to be hoped that the very gratifying state of affairs now prevailing will continue until not only every resident member will make it a point to be present at the regular monthly meetings, but that non-resident members will feel encouraged to attend in considerable numbers.

In this connection we desire to express a hope that the Engineering Societies in Boston and St. Louis may seek to emulate the Societies we have just named. There can be no rivalry between Societies of this character, but such as will be of benefit to all, in the mutual striving after superior excellence, and we will be pleased if these Societies would make use of our columns for the publication of their proceedings and papers, and we feel certain that we can offer them terms more advantageous to them than they can obtain elsewhere.

Personal.

Messrs Chas. G. Darrach and Rudolph Hering, of Philadelphia, Pa., Alphonse Fteley, of Boston, Mass, Peter A. Peterson, of Toronto, Ont., Cleaton B Sears, of the Engineer Corps, U. S. A., and Henry R. Worthington, of New York city, were elected members, and Henry D. Blunden, New York city, was elected Junior, of the American Society of Civil Engineers, January 5th, 1876.

Kansas City Water Works.

We extract the following from the report of the Chief Engineer, G. W. Pearson.

The machinery was built by the Holly Manufacturing Co., of Lockport, New York. It was constructed to meet, and does meet, effectually, the following requirements:

First, to raise the water to the settling basins.

Second, to take it thence and elevate it to the upper reservoir.

Third, to receive it again from the upper reservoir and send it with such pressure added to that derived from the gravity of its descent from the upper reservoir to the pumps, as will enable it to again climb the bluffs with sufficient force to give either domestic supply or fire protection on the highest ground in the city.

Fourth, to be able to do the same work, if needed, without the help of the upper reservoir.

Fifth, to do all this with good economy both in fuel and attendance.

The reason of these requirements has been given; it remains to explain how they are met.

The main engines are four in number, with steam cylinders twenty-two inches in diameter by thirty inches stroke. They stand at an angle of forty-five degrees with the horizon, at each corner of the massive frame work of iron which spans the well; bearing on its top the balance wheel and cranks by which they are all connected in such a manner that each pair takes steam like the cylinders of a locomotive, four times during a revolution, while the opposite engines take steam between these, thus taking steam, when all are working together, at eight equal parts of the revolution.

They are so connected that steam may be admitted to all alike, or to one only, and from this to the other three thus compounding the engines; or all can receive the exhaust steam from the small engine which will be described hereafter.

All the engines can be used with either high or low pressure, and the change is made by simply opening and closing the necessary valves provided for the purpose and requiring but a few moments. The general position of these engines will be understood more readily by referring to the small diagram of their elevation, with their location over the wells.

Six pumps are driven by these engines. Two in the well of fifteen and a half inches diameter by thirty inches stroke are driven by cranks on each end of a shaft under the main shaft, and deriving its motion from it by means of a moveable gear which can be readily used or allowed to stand still while the engines are in action.

These pumps, having to take the water furnished by the syphon, and which at times, is more or less charged with sediment, are so arranged as to be easily packed and, when the cylinders become worn, easily replaced without disturbing other parts of the machinery. All the pump valves are so made as to be easily removed and replaced.

The other four pumps ten and a half inches in diameter by thirty inches stroke, are driven by the extended piston rods of the engines, being coupled to them with keys so that they can be readily attached and let go.

They receive the water which the lower pumps have raised to the east side of the reservoir on its return by the west side, as shown in the diagram, or by opening

the stop valve in the connection of the upper reservoir they may receive their supply from that source with all the aid of its pressure.

In turn, they force it to the upper reservoir (as in the first case) or to the city as in the second, the valves being controlled by the engineer in the building with the same readiness as the steam valves.

The location of the mains in the building is shown in the diagram, the lower pipe reaching to the upper reservoir, the lower one to the city; on the left of the engine is a check valve permitting water to flow from the lower reservoir to the pumps, but closing with the pressure from the upper reservoir, which thus takes its place when the lower valve on the right of the pump is opened. A vertical pipe connects the upper and lower lines as shown, this is closed by another piston valve like the first; when opened the water passes through the vertical pipe into the lower or reservoir line; when closed it passes through the upper line to the city.

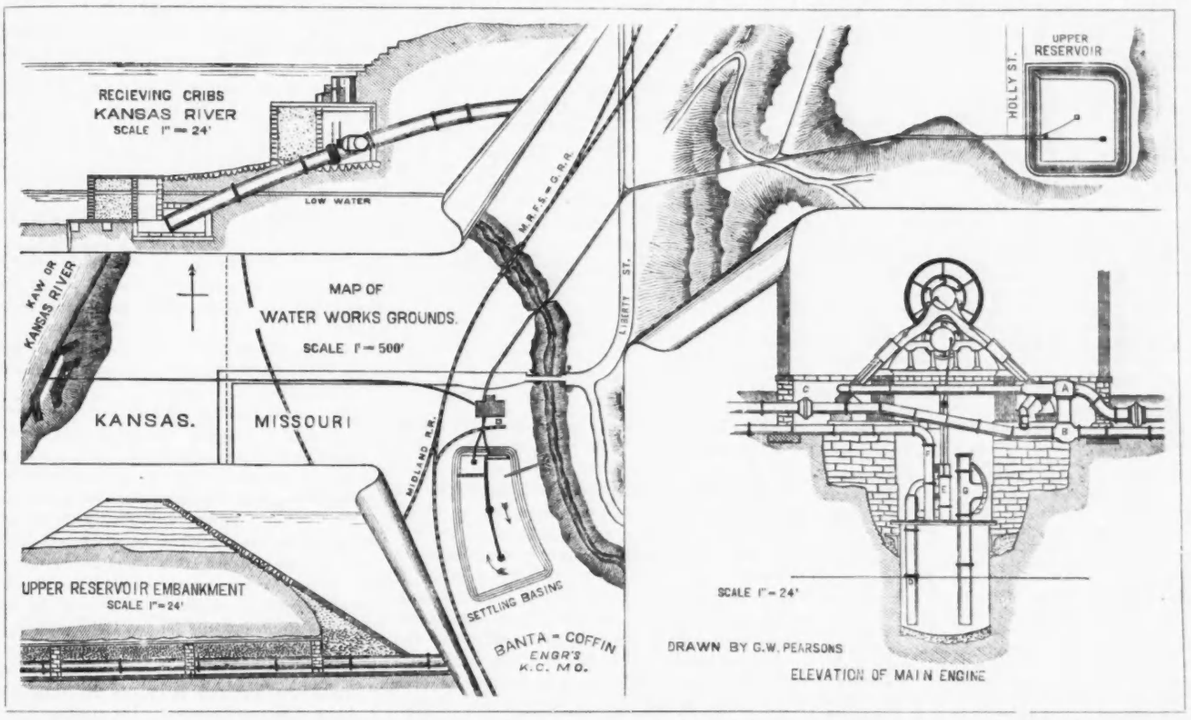
These are double poppet valves like those used in low pressure engines of large dimensions; they are opened and closed by water pistons, driven by admitting water from the mains through a small pipe controlled by a four way stop and waste valve, the changing of which is all the engineer has to do to change the direction of the water flow. An additional main not shown in the diagram, connects the small set of machinery in like manner. The engines have slide valves of uniform movement, the steam passages in the valve chambers are no more than sufficient for the proper flow of steam, the amount admitted is controlled by poppet valves on the top of the steam chests, which are raised by cams on a revolving shaft extending across the frame from engine to engine; these shafts are moved endwise by the action of the governor; the cams are eccentric and tapering; resting on them are steel wheels in the ends of the arms which raise the poppet valves; the shafts make two revolutions to one of the engines, the cut off depending upon the position of the cams which are fast to the shafts.

The governor is entirely different in its action from those in use in ordinary engines, having no relation to the speed of the engine so far as relates to regular movement; its action is derived from the pressure of water in the mains, any deviation from the pressure to which it is adjusted being by it immediately communicated to the cams.

For example, the engines are running at some motion which the governor has by adjusting the cut off cams to their proper position for balancing the pressure given them the proper motion to maintain without increase or diminution; more openings are now made in the mains which by increased water flow with the same supply would diminish the pressure, but the governor, sensitive to the slightest fluctuation, immediately lets on more steam, thus constantly balancing the variable outflow with variable motion.

The cut offs vary the amount of steam admitted from one-eighth to seven-eighths of the stroke, and the motion of the engines has a very wide range, running easily and steadily at four or five revolutions per minute, and just as readily at thirty or forty: as any number of pumps from one to four may be in use at a time, the greatest capacity of the machine is not less than forty times that of its least.

Testing the mains was also a test of the power of the engines to give high pressure without the aid of the back flow from the upper reservoir, it being desirable in these tests to close that line so that in case of accident to the machinery or mains in the building that flood of water should not be let loose upon us; accordingly the mains were tested to a pressure of 240 pounds per square inch at the works, entirely by the direct power of the engines, thus proving their ability to dispense with the use of the upper reservoir, at the same time we were guarding ourselves against accident from it while making the tests.



Besides the six water pumps driven by these engines there are two air pumps for the condenser, one air force pump for keeping the various air chambers supplied with air under pressure, one exhaust air pump for maintaining the vacuum in the great syphon (which also has a connection with the condenser air pumps), and two boiler feed pumps, making in all, twelve pumps driven by these engines.

The water valves are worthy of special mention. They are made of cylinders of hard wood filled and capped with iron; they rest in a bed having the shape of a segment of a cylinder, the water port being long and narrow; a perforated brass cap prevents their displacement, permitting them to rise and fall freely on their seats. They are put in in nests, the aggregate area being from half to two-thirds that of the pistons, their action is remarkably easy and they have proved very durable; a whole set can be taken out and replaced in a few minutes by merely unscrewing the caps over the end of each cylinder.

The engines, like the pumps, can be run in pairs or altogether.

There are three boilers five and a half feet in diameter by sixteen feet long, with fifty-two three and three-quarter inch flues in each, steam domes three by five feet.

The grates are forty-two inches below the boilers; the bridge wall in front has two feet clear space, reduced to eighteen inches at the rear of the boiler; this unusual distance not only of the grates but of the bridge wall from the boiler is the result of careful experiments, and proves in practice to give excellent results in combustion, apparently from the large amount of room given for the products of combustion to mingle before passing into the flues, and by the even heat distributed over the bottom of the boiler.

The smaller set of machinery is, like the larger one, complete in itself, and combines all the requirements of that except the running of the deep well pumps.

It is high or low pressure at the will of the engineer (as are also the large engines), or the steam from this can be admitted to the large engines and drive them by this novel mode of compounding. It has one poppet-valve horizontal engine, sixteen by twenty-eight, driving by means of a pinion two feet in diameter, a gear ten feet in diameter, which swings on top of a frame work like that over the well, and drives by means of cranks at each end of the shaft, four pumps eight by twenty-two inches, located in the places corresponding to the steam cylinders of the large set. It is also furnished with governor, water and air pumps like the larger set.

The gears are all cut, and the workmanship and action of the engines throughout do substantial credit to their builders.

The large set of machinery raises eighty-eight gallons per revolution, allowing for the loss in seating the valves, which is very small.

At twenty-four revolutions per minute, the amount raised is a little over three millions of gallons per day.

At thirty-two revolutions, which is a speed easily maintained; the flow is over four millions of gallons.

The smaller set of machinery raises thirty-eight gallons per revolution, and is designed for running regularly at an extremely low motion; the pumps can be run at less than two revolutions per minute, and up to twenty as readily, giving a capacity of from 100,000 gallons to one million gallons per day.

For fire purposes the machinery can be readily run up to a rate of six millions of gallons per day, or over, while the range of its capacity for regular use is from one hundred thousand gallons to five millions of gallons per day—the extreme minimum being given to enable constant action of the small set of machinery, when, as in the night time it has only a small duty to perform.

The building is so arranged as to admit two more boilers and another large engine without change, and by placing the boilers in a wing in rear of the main building, the capacity of the works can be more than doubled without destroying work already done.

Turkey Creek Bridge, shown in our last issue, needs little further description. In starting the lines from the building both have to cross this stream, as shown in the engraving, which was copied from a photograph. The bottom of this stream is soft and insecure, and the length of time that it is filled with back water from the Kansas river would make the underrunning of it with pipe not only difficult at first but troublesome to repair in case of accident in high water; it was therefore decided to build it as shown.

The upper arch of twenty-inch flanged pipe, sustained by two double wrought-iron chords, carries the water flow to the upper reservoir, and sustains the lower line, which communicates with the city. It is unprotected from the frost, the constant motion of the water in the mains not giving it time to freeze in crossing. During the past winter some trouble was had while the machinery was stopped for repairs of defects during the first tests, but, after regular action was begun, no further trouble was experienced. The abutments of the bridge are of heavy masonry, resting on beds of concrete, several feet below the bed of the stream.

The entire water supply system of Kansas City is owned by a private corporation known as the National Water Works Company of New York, and in the same report from which we have taken the above extract is given the contract between the two parties in full. It is a document that might be of use to other cities which may desire to obtain water under the same conditions, and is of interest to an engineer as suggesting the particulars that are to be provided for in such a case. The report also gives trial tests of the efficiency of the works, together with a schedule of rates charged for water for all purposes.

The reports of the Chief Engineer and of the Committee on Construction go to show that everything connected with the Water Supply System of Kansas City has been done in a first class manner and is alike creditable to the city and to the company owning them.

(Continued from page 83.)

er places, I think there need be but a slight excess of air over that required to consume the coal. The more minute the air streams and the greater velocity with which it rushes amongst the fuel, combined with a high temperature, the smaller will be the additional quantity of air required for dilution.

These remarks must be taken in a general way, as different coals require different means, dependent upon their chemical composition, to burn them perfectly.

In burning coals with a small percentage of hydro-carbons, it may be possible to get a sufficient quantity of air through the grates, but it is not possible with our highly bituminous coals of this section. As I said before, the analyses show that something besides the air which comes through the grates is required to burn up the volatile gases of the coal. Carburetted hydrogen is very difficult to ignite after it is once formed.

To take up these analyses and simply look at them without considering the circumstances under which the gas was formed, they seem to be quite contradictory.

The plan of the grate is quite different, and the blast pipes are differently arranged. And while it is not advisable to undertake, without further experiments, to form decisive conclusions, I think a much greater portion of the heat in the fire-box of a locomotive is dissipated by an excess of air than need be. I think I have pointed out theoretically, in a general way, the loss from too much air, and now the question is pre-eminently a practical one, to see how much can be saved by direct experiment. We want to obtain the best results possible, after taking everything into consideration. I have no doubt but that facilities will be given me to continue my investigations, not only upon locomotives but upon all kinds of furnaces. It is, comparatively speaking, a new field of investigation, but one which cannot fail to give in return important results. I will venture a prediction that with all the economy we can produce by proper admission of air, etc., the waste from ordinary firing will still be so excessive that the conversion of the coal into gas before it is used in locomotives will come into general use in a very few years. As a nation we cannot afford to be so lavish with our fuel as to throw away nine-tenths of its value.

Coals are now bought without any regard to their chemical composition, and it is expected that each kind or variety of bituminous coal will burn equally well in the variously constructed fire-boxes. Because one appliance gives good results with one variety of coal, it does not follow that it will with another which varies in chemical composition. Some coals have a much higher evaporative power than others. A coal containing a large portion of oxygen is not generally as efficient as one which contains less. From experiments made upon the C. & P. R. R., to determine the amount of water evaporated per pound of coal used, we found it to range from six to seven pounds, though in the latter case we must take into consideration the possibility of error of the scales here in Cleveland and those at Wellsville. The sharpness of the blast has much to do with the amount of coal used, and, unless the engine could be run under the same conditions, as to load, speed and pressure, or blast, it would be difficult to judge of the actual value of the coal by the amount of water found to be evaporated, as it depends so much upon manipulation. As these investigations are further pursued, I hope ere long to be able to place before you more conclusive results as to the value of the principles pointed out above, to the manufacturing and railway interests of our country.

Some Remarks on House Drainage.

BY JAMES R. WILLETT, ARCHITECT.

I offer the following memoranda as a short account of how a house may be readily drained in a healthy and practical way, as proved by my own experience in this city. It will be assumed that the dilution of sewage gases by a sufficient quantity of air, will render them innoxious and that the best way to dilute them is to lead them into the ocean of air that lies above our buildings.

It is laid down in the books to disconnect the drains inside the house from those outside by building a grating or trap outside of, and close to the house wall, and letting the drains from inside discharge into it above the ground; this is generally impracticable in cities, and even when it can be done the trap is almost sure to freeze up in very cold weather. I therefore prefer to run the main drain direct to a flue, (made of drain pipe built into a wall,) which leads above the roof, thus giving the sewer ample vent without even the intervention of a trap, and relieving the house pipes of any back pressure from sewer gas.

Catch basins when they communicate with pipes leading up through the roof, as they should do, ought not to be trapped so as to prevent the escape of the gases up the pipe. Air and gas from sewers are warmer, in cold weather, than the atmosphere, and their escape will tend to prevent freezing of the pipes. Down spouts and other pipes which communicate with the sewer without the intervention of a trap, can be recognized in cold weather by the vapor which arises from their openings in the roof.

The books say that soil pipes should be of lead, but my experience leads me to say that they should be of cast iron for the following reasons. I have seen leaden pipes honeycombed so as to be a mere sieve; long

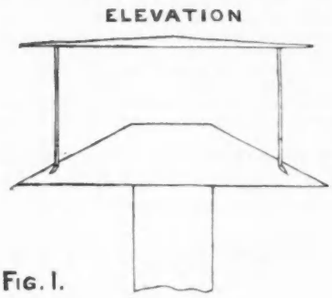
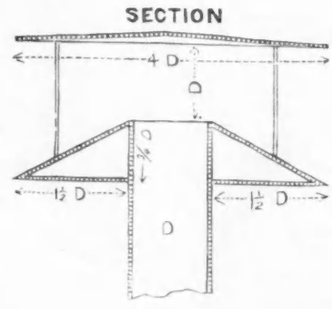


FIG. 1.



lengths of lead pipe even when carefully put up, are apt to sag and tear asunder in the course of time, and workmen can and will, in order to save labor or to pass through a narrow space, compress lead pipe so that it is liable to choke, all of which may be avoided by the use of iron pipe.

All soil pipes, (and waste pipes too,) should be capped by a ventilating top, the best of which, in my opinion, is the old Emerson ejector, Fig. 1, but it should be made as large or larger, and of the pattern shown in the sketch. They are generally made much too small. The rain cover should be very nearly flat, with only just enough fall to prevent water lodging and rusting through, when made of iron. D=diameter of the soil pipe. The dimensions are given in diameters. The waste pipes from safes should also go above roof.

Be sure that the branch pipe from a trap goes horizontally, or very nearly so, to the main waste pipe, as shown in Fig. 2, for this reason it is best generally not

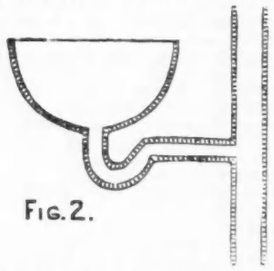


FIG. 2.

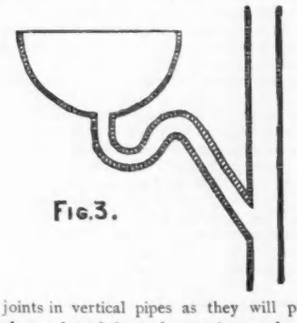


FIG. 3.

to use Y joints in vertical pipes as they will probably cause the longer leg of the syphon to be on the side of the trap toward the waste pipe, as in Fig. 3, which will cause the water to be syphoned out of the trap.

Bell traps, or any trap that can be readily opened and left open, should not be used, especially inside of houses. If possible the soil pipes should run up by a steam pipe, chimney, or other place where it will be heated, which will help to make it draw.

I have tested water closets when there was no water in the traps, the soil pipes of which were put up as described, and I have always found that the flame of a candle would be drawn *into* the trap thus showing its effectiveness.

Civil Engineers' Club of the Northwest.

Report of March Meeting.

The regular monthly meeting of the Club was held on Tuesday evening, the 7th inst., at the Sherman House, President Chesbrough in the chair, and a very large attendance of members and visitors present.

After the reading and approval of the minutes of last meeting the following persons were elected to membership:—

John A. Cole, C. E., of Chicago; John Nicholl, C. E., of Milwaukee; George T. Neally, C. E., of Burlington, Iowa; Lorenzo M. Johnson, C. E., of Keokuk, Iowa; and John E. Thomes, C. E., of Chicago.

The following nominations for membership were then made:—

Francis Walker, of Chicago, proposed by R. J. McClure and Max Hjortsberg; W. H. Newton, C. E., proposed by O. B. Green and Max Hjortsberg; G. F. Kirby, of Chicago, proposed by Willard S. Pope and W. Sooy Smith; G. A. Case, of Chicago, proposed by W. M. R. French and S. S. Greeley; Henry Stewart, of New York city, proposed by Geo. H. Frost and S. S. Greeley; Chas. P. Roney, of Chicago, proposed by E. S. Chesbrough and Geo. H. Frost.

The paper for the evening, entitled "RIPARIAN RIGHTS," by S. S. Greeley, was read and discussed.

The President then submitted a communication which he had received from the Committee appointed by the American Society of Civil Engineers, for the representation of Civil Engineering at the Centennial Exposition, requesting the co-operation of the members of the Club in making the proposed exhibition of Engineering a successful one. W. Sooy Smith, in explanation, stated that space had been granted for an exhibition of Engineering, but it had to be properly furnished and cared for; the American Society proposed to rent rooms for the use, as headquarters, of Civil Engineers visiting the Exhibition, and for this purpose had joined with the American Institute of Mining Engineers. The expenses of keeping these rooms open and in order, and for salaries of the persons in charge would be considerable, amounting to about $5000, and it was expected that the profession throughout the entire country would be glad to assist in raising the necessary amount. It was also expected that Contractors, and others who were engaged in works under the superintendence of engineers, would contribute to this fund, as in this exhibition of the engineering progress of the country, they were to a large extent advertised and benefitted, even more than the engineers were.

The President again urged the subject upon the attention of the members, and stated that Mr. Smith and he proposed to wait upon parties outside of the profession in behalf of the fund, and he was in hopes that at least $500 would be raised in Chicago.

The report of the Committee on Nominations, recommending an amendment to the constitution was then read and moved for adoption.

Section 1 of the proposed amendment was freely discussed by the President and Messrs. Pope, Smith, Morehouse, Greeley, French and Williams, and was finally passed by a unanimous vote in the following form:

"Persons who are, or who may have been engaged in the practice of Engineering or Surveying, and graduates of any Engineering school or of the Engineering department of any University, are eligible as members of this Club."

Section 2, as given in ENGINEERING NEWS of Feb. 5, was passed without discussion.

On motion, a special committee consisting of Messrs. Greeley, Smith and French, were appointed to consider the request of the Boston Society of Civil Engineers in

the proposed adoption of the Metric System of Weights and Measures.

The Secretary read a letter from J. Howard Ellers, urging the necessity of procuring rooms for the Club which should be headquarters for the profession in the Northwest.

A donation from W. H. Dall of the U. S. Coast Survey, of lithographed maps of surveys made by him in Alaska, was received; also one from Buff and Berger of a photograph of a portable transit instrument, made by them for the use of the U. S. Lake Survey at Detroit.

The Secretary stated that he had another paper on the subject of a new style of raiload which had been sent by C. J. Quetil, C. E., of New York city, and which he believed would prove of considerable interest to the members of the Club. In consequence of the lateness of the hour, however, several members had already been obliged to leave in order to catch the evening trains home, and others would have to leave in a few minutes. As Mr. Quetil's paper was to be published under the auspices of the Cheap Transportation Society of New York, during the month, the Club decided to omit the reading of it until the next meeting.

The meeting then adjourned.

PUBLICATIONS RECEIVED.

Third Annual Report of The Board of Water Commissioners of the city of Yonkers, N. Y. December, 1875.

Journal of the American Society of Civil Engineers for January 1876. N. Y.

Sixth Annual Report of the Acushnet Water Board. New Bedford, 1876

Annual Report of the Mayor, with the Department Reports of the City of Middletown, Conn., for the year ending January, 1876.

General Report of the Minister of Public Works of the Dominion of Canada, for the Year ending June 30, 1875. Ottawa, 1876.

Constitution and By-laws of the Engineers' Club of St. Louis, Mo. 1870.

From the Institute of Civil Engineers. *List of Members of the Institute.* Feb. 1, 1876.

The Manora Breakwater, Kurrachee, by William Henry M. Pierce, Inst. C. E. London, 1875.

Annual Report for the Years 1863, 1871–2–4 of the Board of Regents of the Smithsonian Institute, Washington.

Report of the Commissioner of the U. S. Commission of Fish and Fisheries, for 1872 and 1873.—Part II, Containing an "Inquiry into the decrease of the Food Fishes" and "The Propagation of Food Fishes in the Waters of the United States." Washington, 1874.

Transactions of the Wisconsin Academy of Sciences, Arts and Letters. Vol. I, 1870–2, Vol. II, 1873–4. Published by order of the Legislature. Madison.

The Scientific Monthly. An Illustrated Magazine, devoted to the Natural Sciences. Published at Toledo, Ohio, at Three Dollars a year in advance. Contents of the February Nnmber occupy 60 pages and are fully illustrated. They are all original and we trust that the enterprising editor, Mr. E. H. Fitch, a well known and enthusiastic Naturalist, will receive the support from the science loving portion of the community that he so well deserves.

The Home Scientist. A Monthly eight-page "Journal of Knowledge for the People," published at Wadsworth, Ohio, is the latest contribution to Scientific journalism. It is edited by Rev. Edward Brown, A. M., and among its engaged contributors are some of the most eminent scientists of the country. Its low price of *One Dollar* per year ought to ensure its introduction into every family where a love of popular science exists.

Contractors' Intelligence.

Worthington & Co., of New York, are building the engines for the water works at Cleveland, Ohio.

The contractors, Phelps, King & Co., have contracted for the iron for the Dayton and Southeastern road from the Cambria Iron Works, at Johnstown, Pa. The rails are to weigh 35 lbs. per yard.

Monmouth has raised $40,000 for building the B. M. and I. R. narrow-gauge, and the work will be commenced immediately, in order to finish the road before the end of the year. Surveyors will begin operations shortly.

The contract for the grading of the 8th Division of the Dayton and Southeastern R. R. (narrow-gauge), has been sub-let to two parties, and the work is being vigorously prosecuted near Eureka, Jackson County, Ohio.

A. Knisely & Co., of this city, have just finished one of the largest sky-lights in the country, 60 x 84 ft., being the entire roof for the Detroit Public Library. Hayes' Patent was used throughout, and entire satisfaction is the result.

A certificate of organization was issued by the Secretary of State of Illinois, last Monday, to the Eureka Bridge and Iron Company, of Chicago; capital $100,000. The corporators are A. Courter, S. B. Munson, Jr., and A. T. Bates.

The Knowles Pump-works, Warren, Mass., shipped, a few days ago, another of their large steam pumps for the Chicago water works. The pump weighs 19,000 lbs., and has a capacity of raising three million gallons of water a distance of 150 feet per day. Another of their pumps has just been sent to Liverpool, England.

The foundations of the new building, for the State Institute for Feeble Minded Children, at Lincoln, Ill., the contract for which was awarded last October to Mr. Thos. E. Courtenay of Chicago, are all laid. The subcontracts for different parts of the building have been relet by Mr. Courtenay, and a large quantity of material, including 300,000 brick, is on the ground awaiting favorable weather. The building, which is to be three stories and basement, is to be of brick with stone trimmings, and by the terms of the contract is to be finished Dec. 20th, 1876, the cost being $125,000.

The long-talked-of Lehigh and Eastern Railway, which is to extend from Tomhicken, near Hazleton, to a connection with the Erie at Port Jervis, N. Y., is to be built soon. At a meeting of the directors and stockholders, held last week, President Kase stated that the right of way had about all been secured, and that the work of grading would be immediately begun, and that the road would be in running order during the coming summer. The road will cross Pocono Mountain a few miles north of Stroudsburg, thence pass up the Pennsylvania side of the Delaware river, crossing the same near the point of connection.—*Mauch Chunk Coal Gazette.*

Proposals for Contracts.

We call the attention of our friends to the importance of the List of Contracts which we are endeavoring to make a feature of our journal, and we request that they will assist us in making it of interest by mailing us local papers containing "Proposals for Contracts," or sending us slips cut from such papers. It takes time to get into good running order, but we will accomplish our purpose after a while to the satisfaction, we trust, of the large number of our readers who are interested in this subject.

SCHOOL BUILDING.—Sealed proposals will be received at the office of the Clerk of the Board of Education, No. 85 Fifth av., till Thursday, March 16, 1876, at 12 m., for the erection of a twelve-room brick school building on Throop street, south of Eighteenth street, in accordance with plans and specifications to be seen at the office of W. J. Edbrooke, architect, No. 170 East Madison street, Room 11. Proposals must be submitted separately, as follows: For masonry and deafening of the floors; for cut stone; for carpentry; for galvanized iron cornice and conductor pipes; for composition roof; for plastering; for hot air pipes and registers; for painting and glazing; for plumbing; for sewerage, and for asphalt pavement in the basement. Thomas Wilce, John P. Olinger, Adolph Shoenenger. *Committee on Buildings and Grounds.*

SCHOOL SITE.—Sealed proposals will be received at the office of the Clerk of the Board of Education, No. 85 Fifth av. till Thursday, March 16, 1876, at 12 m., for the sale to the city of a school site in the vicinity of Oak and Bremer streets, or within a radius of five or six blocks from said locality. Proposals will also be considered from south of Chicago avenue. Size to be from 150 to 200 feet front. Address proposals to "Committee on Buildings and Grounds," indorsed "Proposal for School Site." Thomas Wilce, John P. Olinger, Adolph Shoeninger. *Committee on Buildings Gronnds.*

COUNTY POORHOUSE—Sealed proposals will be received until Tuesday the fourth day of April, at 12 o'clock noon, for the building of an additional Ward to the County Poorhouse building, according to plans and specifications to be seen at the office of the County Auditor, Marion, Iowa. By order of the Supervisors. Joseph Whitney, *Chairman.*

IMPROVEMENT OF TENNESSEE RIVER—Sealed proposals, in duplicate, will be received at this office until noon on Wednesday, March 22, 1876, for the construction of Locks in the Muscle Shoals Canal, Tennessee River, between Florence and Decatur, Alabama. Walter McFarland, *Major of Engineers*

U. S. Engineer Office, Chattanooga, Tenn., February 7, 1876.

JAIL AND SHERIFF'S RESIDENCE.—Sealed proposals will be received at the County Clerk's office in the city of Freeport, Ill., until March 22, 1876, at noon, for the furnishing of all materials and labor required in the erection, construction, and completion of a Jail and Sheriff's Residence in the city of Freeport, for the County of Stephenson, State of Illinois, according to plans and specifications for the same as furnished by T. J. Tolan & Son, Architects, of Ft. Wayne, Ind. Said buildings will be required to be finished and completed on or before the first day of November, 1876. I. F. Kleckner, *County Clerk.*

Freeport, Ill., Feb. 25, 1876.

SCAVENGER WORK.—Sealed proposals for the performance of the day scavenger work of Chicago, from May 1, 1876, will be received at the office of the Board of Health, No. 16 Honore Block, until 12 m. of Tuesday, March 14, 1876. G. W. Merrell' *Secretary Board of Health.*

Chicago, March 1, 1816.

TO RAILROAD CONTRACTORS—The "Wheeling and Lake Erie Railroad Company" invite proposals until March 20, 1876 (either separately or combined), for the construction and equipment of its line of road between Martin's Ferry and Sandusky, O., or for parts thereof. Also for railway materials. Particulars furnished on application. Joel Wood, *President.*

Martin's Ferry, O., Feb. 22, 1876

SCHOOL HOUSE.—Sealed proposals will be received at the office of the Clerk of the Board of Education of Northampton Township, Summit County, Ohio, until 12 o'clock at noon, on the seventeenth day of April 1876, for building a School House on the lot situated in Sub-district No. 1, according to the plans and specifications on file in said office.

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